U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Tryonia cheatumi*

COMMON NAME: Phantom springsnail (Phantom tryonia)

LEAD REGION: Region 2

INFORMATION CURRENT AS OF: April 2010

STATUS/ACTION:
___ Species assessment - determined species did not meet the definition of endangered or threatened under the Endangered Species Act (Act) and, therefore, was not elevated to Candidate status
___ New candidate
_X_ Continuing candidate
___ Non-petitioned
_X_ Petitioned - Date petition received: May 11, 2004
_ 90-day positive - Federal Register (FR) date:
_ 12-month warranted but precluded - FR date:
_ Did the petition request a reclassification of a listed species?

FOR PETITIONED CANDIDATE SPECIES:
a. Is listing warranted (if yes, see summary of threats below)? yes
b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? yes
c. If the answer to a. and b. is "yes", provide an explanation of why the action is precluded.

Higher priority listing actions, including court-approved settlements, court-ordered statutory deadlines for petition findings and listing determinations, emergency listing determinations, and responses to litigation, continue to preclude the proposed and final listing rules for the species. We continue to monitor populations and will change its status or implement an emergency listing if necessary. The "Progress on Revising the Lists" section of the current Candidate Notice of Review (CNOR) (*http://endangered.fws.gov/*) provides information on listing actions taken during the last 12 months.

___ Listing priority (LP) change
Former LP: ___
New LP: ___

Date when the species first became a Candidate (as currently defined): October 30, 2001

___ Candidate removal: Former LP: ___

___ A – Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
____U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.
___ F – Range is no longer a U.S. territory.
___ I – Insufficient information exists on biological vulnerability and threats to support listing.
___ M – Taxon mistakenly included in past notice of review.
___ N – Taxon does not meet the Act's definition of "species."
___ X – Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Snails, Hydrobiidae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Texas

CURRENT STATES/ COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Texas, Reeves and Jeff Davis counties

LAND OWNERSHIP**:** Land ownership is about 33 percent Federal (Phantom Lake Spring – Bureau of Reclamation (Reclamation) owns 17 acres (ac) (6.9 hectares (ha)) around the spring); 33 percent State (San Solomon Spring – Balmorhea State Park, Texas Parks and Wildlife Department (TPWD) owns 46 ac (18.6 ha) around the spring); and 33 percent private (East Sandia Spring – The Nature Conservancy (TNC) owns 240 ac (97 ha) around the spring). The following acreage estimates are based on actual surface water assumed inhabited at each spring location: Phantom Lake Spring = 0.07 ac (0.03 ha); San Solomon Spring = 8 ac (3.2 ha); East Sandia Spring = 0.07 ac (0.03 ha). Lands in watersheds surrounding the spring habitats are all privately owned.

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BIOLOGICAL INFORMATION:

<u>Species Description and Taxonomy</u>: The Phantom springsnail was first described by Pilsbry (1935, p. 91). It is a very small snail, measuring only 0.11 inch (in) (2.9 millimeters (mm)) to 0.14 in (3.6 mm) long (Taylor 1987, p. 39). The shell is narrowly conical, with an obtuse apex and a broadly rounded anterior end (Taylor 1987, p. 39). Whorls are 4.75 to 5.75 in. (121 to 0.146 mm) in larger males and 5 to 6 in. (127 to 152 mm) in larger females, regularly convex, and separated by a deeply incised suture (Taylor 1987, p. 39). Recent systematic studies (Hershler *et al*. 1999, pp. 377-391) of snails in the Family Hydrobiidae have been conducted using mitochondrial DNA sequences and morphological characters. These analyses support the

unique taxonomic status of the Phantom springsnail. Phantom springsnail was assigned to a clade of "true *Tryonia*" made up of 16 species in southwestern North America (Hershler *et al*. 1999, pp. 384-386). Thus, we have carefully reviewed the available taxonomic information to reach the conclusion that *T. cheatumi* is a valid taxon.

<u>Life History/Biology</u>: Habitat of the species is found on soft and firm substrates (rocks and vegetation) on the margins of spring outflows (Taylor 1987, p. 41). Snails of the family Hydrobiidae are sexually dimorphic with females being characteristically larger and longer-lived than males. The snails are ovoviviparous, producing live young serially (as opposed to broods). They are fine-particle feeders presumably eating detritus and periphyton associated with the substrates (mud and vegetation); Dundee and Dundee (1969, p. 207) found diatoms to be the primary component in the digestive tract.

In the desert southwest, aquatic snails are distributed in isolated geographically-separate wetland populations (Hershler *et al*. 1999, p. 377). They likely evolved into distinct species during recent dry periods (since the Late Pleistocene, within the last 100,000 years) from parent species that once enjoyed a wide distribution during wetter, cooler climates of the Pleistocene. Such divergence has been well-documented for aquatic and terrestrial macroinvertebrate groups within arid ecosystems of western North America (e.g., Taylor 1987, pp. 1-50; Bowman 1981, p. 15; Brown *et al*. 2008, p. 486).

<u>Historical and Current Range/Distribution</u>: The Phantom springsnail is an aquatic snail occurring in only three spring systems and associated outflows (Phantom Lake, San Solomon, and East Sandia springs) in the Toyah Basin of Jeff Davis County and Reeves County, Texas (Taylor 1987, pp. 40-41). The Phantom springsnail may also occur at Giffin Spring, in the same area, but information is not available from that site because access is limited by the private landowner. There is no available information that indicates the species' historic distribution was larger than the present distribution. Other area springs may have contained the same species, but because these springs have been dry for many decades, there is no opportunity to determine the potential historic occurrence of the snail fauna.

Another endemic hydrobiid aquatic snail, Brune's tryonia (*T. brunei*), may also have occurred historically in lateral canals at Phantom Lake Spring (Taylor 1987, pp. 40-41). A study of phylogenetic relationships was unable to relocate this species (*T. brunei*) (Hershler *et al*. 1999, p. 379). No confirmed occurrence of this species has been made since the original description by Taylor (1987, p. 44). Brune's tryonia may now be extinct due to loss of habitat from spring flow cessation. An additional endemic hydrobiid aquatic snail, Phantom Cave snail (*Cochliopa texana*), has essentially the same current distribution as the Phantom springsnail and is also a candidate for Federal listing.

<u>Habitat</u>: The Phantom springsnail only occurs in desert spring outflow channels. They are most abundant in the first few hundred meters downstream of spring outlets. Habitat of the species is found on both soft and firm substrates on the margins of spring outflows (Taylor 1987, p. 41). They are also commonly found attached to plants, particularly in dense stands of submerged *Chara* beds.

In addition to rare snails, these springs (Phantom Lake, San Solomon, Giffin, and East Sandia) are also important aquatic habitat for two listed endangered fish species, the Comanche Springs pupfish (*Cyprinodon elegans*) and the Pecos gambusia (*Gambusia nobilis*), and the endemic diminutive amphipod (*Gammarus hyalleloides*), a candidate for Federal listing.

<u>Population Estimates/Status</u>: Within its limited range, Phantom springsnail can have very high densities of abundance. Dundee and Dundee (1969, pp. 205-207) described the conditions of Phantom springsnail at Phantom Lake Spring in 1968. Despite the fact that Phantom Lake Spring has been drastically altered from its original state, the native snails (Phantom springsnail and Phantom Cave snail) occurred in the irrigation canal in such tremendous numbers that the sides of the canal appeared black from the cover of snails. Today the snails are limited to low densities in the small pool at the mouth of Phantom Cave and cannot be found in the irrigation canal downstream (Allan 2008, p. 1). A similar situation occurs at San Solomon Spring, where Taylor (1987, p. 41) reported the Phantom springsnail was abundant and generally distributed in the canals from 1965 to 1981. No published information is available on population abundance of the species at San Solomon Spring.

In the summer of 2000, East Sandia Spring was surveyed for aquatic macroinvertebrates for the first time. A healthy abundance and diversity of snails and other macroinvertebrates were present in the spring head and small outflow channel. The entire available habitat is estimated at less than 492 feet (ft) (150 meters (m)) long, and usually 3 ft (1 m) wide or less.

THREATS:

We have no new information as of April 2010 regarding threats to the species.

A. <u>The present or threatened destruction, modification, or curtailment of its habitat or range</u>.

<u>Water Quantity</u>: The primary threat to the continued existence of the Phantom springsnail is the degradation and eventual loss of spring habitat (flowing water) due to the decline of groundwater levels of the supporting aquifer. The San Solomon Spring System (System) is located in the Toyah Basin at the foothills of the Davis Mountains near Balmorhea, Texas. In addition to being an important habitat for rare aquatic fauna, area springs are also an important source of irrigation water for the farming communities in the Toyah Basin. Phantom Lake Spring is in Jeff Davis County, while the other major springs in this system are in Reeves County. The Water District diverts water from the springs using a system of canals to irrigate area fields.

Pumping of the regional aquifer for agricultural production of crops has resulted in the drying of other springs in this region (Brune 1981, pp. 258-260). Other springs that have already failed include Comanche Springs, which was once a large surface spring in Fort Stockton, Pecos County, Texas (about 50 miles (mi) (80 kilometers (km)) east of Balmorhea). Prior to the 1950s, this spring flowed at more than 42 cubic-feet per second (cfs) (1.2 cubic meters per second (cms)) (Brune 1981, p. 358) and provided habitat for rare species of fishes and invertebrates, likely including aquatic snails. The spring ceased flowing by 1962 (Brune 1981, p. 358). Leon

Springs, located about 40 mi (64 km) east of Balmorhea in Pecos County, was measured at 18 cfs (0.5 cms) in the 1930s and was also known to contain rare fish, but ceased flowing in the 1950s following significant irrigation pumping (Brune 1981, p. 359).

The general physiographic setting of the spring system is that of a largely alluviated, arid, karst terrain. The aridity of the region restricts the available habitat for spring-dependent species and limits the available recharge to replenish and maintain spring flow. Surface waters in the area that provide habitat for the snails are exclusively supported by spring flows that discharge from groundwater aquifers. Many of the aquifers in west Texas receive little to no recharge (Scanlon *et al*. 2001, p. 28) and are influenced by regional flow patterns (Sharp 2001, p. 41). Management and conservation of these aquifers is the key for ensuring the continued survival of rare species in the spring habitats (Bowles and Arsuffi 1993, p. 327). Historically, the springs in this spring system were likely periodically interconnected as portions of the Toyah Creek watershed. In recent times, manmade structures altered the patterns of spring outflows and stormwater runoff from the watershed.

The base flows from these springs are likely discharge points of a regional flow system from aquifers associated with the Salt Basin, west of the Delaware Mountains, and Wildhorse Flat, west of the Apache Mountains, Culberson County (Sharp 2001, p. 42; Sharp *et al*. 2003, pp. 8-9; Texas Water Development Board 2005, p. 106). The relationships of the supporting aquifers for the springs are not fully defined. However, studies (LaFave and Sharp 1987, p. 9; Schuster 1997, p. 97; Sharp *et al*. 1999, pp. 2-4) indicate that "base flow" comes from a regional groundwater system, while the springs respond to runoff from the Davis Mountains, sometimes resulting in flow spikes following rainfall events. Similar water chemistry, water age, and near constant temperatures of about 79 degrees Fahrenheit (^{o}F) (26 degrees Celsius (^{o}C)) among three of the area springs (Phantom Lake, San Solomon, and Giffin) indicate that their waters likely originate from the same source of Cretaceous Limestone (Schuster 1997, pp. 43-44). East Sandia waters are likely a result of shallower, local groundwater sources (Schuster 1997, pp. 92-93).

An assessment of the springs near Balmorhea by Sharp (2001, p. 49) concluded: "The effects of humans on the Toyah Basin aquifer have been significant. Irrigation pumpage increased rapidly after 1945. Many springs in the area have since ceased to flow (Brune 1981, pp. 382-383). Irrigation pumpage from the Toyah Basin lowered water-table elevations and created a cone of depression (that is a lowering of the groundwater elevation around pumping areas). Thus, pumpage totals altered the regional-flow-system discharge zone from the Pecos River to irrigation wells within the Toyah Basin (Schuster 1997, pp. 16-19; Boghici 1997, pp. 100-108). Recent declines of pumpage for irrigation because of economic conditions have allowed partial recovery of water levels, but it seems doubtful that predevelopment conditions will be achieved."

Ashworth *et al*. (1997, pp. 1-13) provided a brief study to examine the cause of declining spring flows in the Toyah Basin. The conclusion from this study suggested that recent declines in spring flows are more likely to be the result of diminished recharge due to the extended dry period rather than from groundwater pumpage (Ashworth *et al*. 1997, p. 5). Although certainly a factor, drought is unlikely the only reason for the declines because the drought of record in the 1950s had no effect on the overall flow trend (Allan 2000, p. 51; Sharp 2001, p. 49). The Texas

Water Development Board (2005, pp. 1-120) provided a thorough review of the hydrogeology and the regional flow system for the springs that support this species. The complexity of the aquifer system and the limited availability of data result in a high level of uncertainty about the cause of spring flow declines. However, the report concluded that, "…if most of the base flow to the springs consists of ancient groundwater that accumulated long ago, any extraction of this water from the system anywhere along the flow path may adversely affect water levels" (Texas Water Development Board 2005, p. 108).

Phantom Lake Spring: Phantom Lake Spring is located at the base of the Davis Mountains, about 4 mi (6.4 km) west of Balmorhea State Park, just over the Reeves County line in Jeff Davis County. The 17-ac (6.9-ha) site around the spring and cave opening is owned by the Bureau of Reclamation (Reclamation). The site includes a 394 ft (120 m) pupfish refuge canal and is surrounded by an outcrop of limestone cliffs. When water was present from the spring, it was an important site for wildlife, especially small mammals, bats, and birds.

Historically, Phantom Lake Spring was a large desert ciénega with a pond of water more than several acres in size (Hubbs 2001, p. 307). Ciénega is a Spanish term that describes a spring outflow that is a permanently wet and marshy area. The spring outflow is at about 3,543 ft (1,080 m) in elevation and previously provided ideal habitat for the endemic native aquatic fauna. Flow from Phantom Lake Spring was originally isolated from the other waters in the system, and the spring discharge quickly recharged back underground before reaching Toyah Creek. Modifications to the spring outflow channeled waters into Toyah Creek, west of San Solomon and Giffin springs for use by local landowners and irrigation by the Water District. Flows from Phantom Lake Spring have been declining since measurements were taken in the 1930s, (Brune 1981, p. 259) and have not been sufficient to support irrigation by the Water District since the 1990s. During the 1940s the spring outflow was modified into a concrete-lined irrigation ditch so that the total outflow from the spring could be captured and used for irrigation of agriculture lands (Bogener 2003, pp. 4-5). The native aquatic fauna persisted, though probably in reduced numbers, in the small pool of water at the mouth of the spring (Phantom Cave) and in the irrigation canals downstream.

Phantom Lake Spring has experienced a long-term, consistent decline in spring flows. Discharge data have been recorded from the spring six to eight times per year since the 1940s by the U.S. Geological Survey (Schuster 1997, p. 90). The record shows a steady decline of flows, from greater than 10 cfs (0.3 cms) in the 1940s to 0 cfs (0 cms) in 2000. The data also show that the spring can have short-term flow peaks resulting from local rainfall events in the Davis Mountains (Sharp *et al*. 1999, p. 4). These flow peaks are from fast recharge and discharge through the local aquifer system. The flow peaks do not reflect direct surface water runoff because the outflow spring is within an extremely small surface drainage basin which is not connected to drainage basins from the Davis Mountains upslope. However, after each increase, the base flow has returned to the same declining trend within a few months. The exact causes for the decline in flow from Phantom Lake Spring are unknown. Some of the possible reasons are groundwater pumping of the supporting aquifer and decreased recharge of the aquifer from drought (Sharp *et al*. 1999, p. 4; Sharp *et al*. 2003, p. 7).

Exploration of Phantom Cave by cave divers has led to additional information about the nature of the spring and its supporting aquifer. Beyond the entrance, the cave is a substantial conduit that transports a large volume of water generally from the northwest to the southeast, consistent with regional flow pattern hypothesis. Over 8,000 ft (2,438 m) of the cave conduit have been mapped. In addition, flows have been measured and are in the 25 cfs (0.7 cms) range. The relatively small historic flow at Phantom Lake Spring is essentially an overflow of a larger flow system underground. Waters from Phantom Lake Spring issue at a higher elevation than other springs in the system, resulting in Phantom Lake Spring being the first to be impacted by declining groundwater levels.

A pupfish refuge canal was built by Reclamation in 1993 (Young *et al*. 1993, pp. 1-3) to increase the available aquatic habitat at Phantom Lake Spring. Winemiller and Anderson (1997, pp. 204-213) showed that the refuge canal, although it was an artificial habitat, was used by endangered fish species when water was available. Stomach analysis of the endangered pupfish from Phantom Lake Spring showed that the snails were a part of the fish's diet (Winemiller and Anderson 1997, pp. 209-210). The refuge canal was constructed for a design flow down to about 0.5 cfs (0.01 cms), which at the time of construction was the lowest flow ever recorded out of Phantom Lake Spring. Recent loss of spring flow has eliminated the usefulness of the refuge canal because it is has been dry since the summer of 2000 (Allan 2000, p. 51).

Phantom Lake Spring ceased flow during the summer of 2000 and has not recovered. All that remained of the spring outflow habitat was a small pool of water, with about 540 ft^2 (50 m^2) of surface area. In May 2001, Reclamation, in cooperation with the Service, installed an emergency pump to move water from within the cave to the springhead, as a temporary measure to prevent complete drying of the pool. Habitat for the snails at Phantom Lake Spring is now limited to this small pool. Despite the fact that Phantom Lake Spring has been drastically altered from its original state, the native aquatic fauna are maintaining minimal populations there. Hubbs (2001, pp. 323-324) documented changes in water quality (increased temperature, decreased dissolved oxygen, and decreased coefficient of variation for pH, turbidity, ammonia, and salinity) and fish community structure at Phantom Lake Spring since natural flows ceased. Starting in the summer of 2004, Phantom Lake Spring experienced flood flows sporadically over the subsequent two years. However, within a few months following these increases, flows returned to at or near zero.

The current status of aquatic habitat at Phantom Lake Spring is very poor. Efforts are ongoing to improve the pump system, but conservation actions have not enhanced the situation. The pump system failed several times during 2008, resulting in stagnant pools and near drying conditions. The pump system was stabilized in 2009 and the species remains extant but natural spring flows do not appear to be recovering. The loss of the population of the species at Phantom Lake Spring appears imminent.

San Solomon Spring: San Solomon Spring, in Reeves County, is by far the largest spring in the Balmorhea area (Brune 1981, p. 384). It provides the water for the swimming pool at Balmorhea State Park and most of the irrigation water for the Water District. Balmorhea State Park encompasses about 45.9 ac (18.6 ha) southwest of Balmorhea in Reeves County. The park is owned and managed by Texas Parks and Wildlife Department (TPWD). Park facilities were built by the Civilian Conservation Corps in the early 1930s and were opened as a state park in 1968. The entire spring head was converted into a concrete-lined swimming pool. The outflow from the pool is completely contained in concrete irrigation channels. A refuge canal encircling the historic motel was also built in 1974 to create habitat for the endangered fishes.

In 1996, TPWD created the San Solomon Ciénega (located on the Park, a few hundred meters downstream of the spring opening/swimming pool and adjacent to irrigation canals) which uses some spring flow to recreate more natural aquatic habitats for the benefit of the endangered fishes in Balmorhea State Park (McCorkle *et al*. 1998, pp. 36-40; Garrett 2003, pp. 151-160). It was designed to resemble and function like the original ciénega for the native aquatic fauna. The Water District and the local community it represents agreed to provide the essential water needed to create a secure environment for the endangered species. The main purpose of this restoration project was to recreate vital habitat, not only for the two endangered fishes, but for other aquatic, terrestrial, and wetland-adapted organisms as well (McCorkle *et al*. 1998, pp. 36-41; Garrett 2003, pp. 151-160).

The concrete canal encircling the motel was deteriorating and causing problems with the foundation of the motel. In 2009 and 2010 TPWD, in consultation with and funding assistance from the Service, constructed a second small additional ciénega habitat just north of the existing refuge canal. By relocating the canal to the north and providing a new ciénega, the aquatic habitat available for the native fishes and invertebrates at the Park will be increased in size and enhanced in nature. The project is being completed in 2010 (Lockwood 2010).

The artesian spring issues from the lower Cretaceous limestones at an elevation of 3,346 ft (1,020 m). Although long-term data are scarce, San Solomon Spring flows have declined somewhat over the history of record, but not as much as Phantom Lake Spring (Schuster 1997, pp. 86-90; Sharp *et al*. 1999, p. 4). Some recent declines in overall flow have likely occurred due to drought conditions and declining aquifer levels (Sharp *et al*. 2003, p. 7). San Solomon Spring discharges are usually in the 20 to 30 cfs (0.6 to 0.8 cms) range (Ashworth *et al*. 1997, p. 3; Schuster 1997, p. 86) and are consistent with the theory that the water bypassing Phantom Lake Spring discharges at San Solomon Spring.

Giffin Spring: This spring is located less than 1.0 mi (1.6 km) west, across State Highway 17, from Balmorhea State Park. Access is limited because the spring is on private property. Brune (1981, pp. 384-385) documented a gradual decline in flow from Giffin Spring between the 1930s and 1970s, but surprisingly the discharge has remained near constant in recent decades, with outflow of about 3 to 4 cfs (0.08 to 0.1 cms) (Ashworth *et al*. 1997, p. 3). The outflow channel has been modified (dammed and channelized) to accommodate irrigation for downstream canals. The Phantom springsnail likely occurs here, but has not been confirmed.

East Sandia Spring: East Sandia Spring is located approximately 2 mi (3.2 km) east of Balmorhea near the community of Brogado. The Spring is included in a 240-ac (97-ha) preserve owned and managed by TNC (Karges 2003, pp. 145-146). Included on the site, a significant sacaton grassland (coarse grass) is associated with the habitat.

Flows from East Sandia Spring are likely from a shallow groundwater source as water chemistry differences indicate it is not directly connected with other Toyah Basin springs (San Solomon Spring, Phantom Lake Spring, and Giffin Spring) in the nearby area (Schuster 1997, pp. 92-93). East Sandia Spring discharges at an elevation of 3,224 ft (977 m) from alluvial sand and gravel (Schuster 1997, p. 92). Brune (1981, p. 385) noted that flows from Sandia Springs were declining. East Sandia may be very susceptible to over pumping in the area of the local aquifer that supports the spring. Measured discharges in 1995 and 1996 ranged from 0.45 to 4.07 cfs (0.013 to 0.12 cms) (Schuster 1997, p. 94). The small outflow channel from East Sandia Spring has not been significantly modified and water flows into the Water District irrigation system about 328 to 656 ft (100 to 200 m) after surfacing. West Sandia Spring also occurs on the TNC preserve, but it ceased flowing over long periods of time (Schuster 1997, p. 93). The presence of rare species there is not likely.

Irrigation Canals: The Water District maintains an extensive system of over 60 mi (97 km) of irrigation canals that provide minimal aquatic habitat for the native species. Most of the canals are concrete-lined with high velocities and little natural substrate available. Many of the canals are regularly dewatered as part of the normal Water District operations for water management.

Climate Change: Future climate change may also impact water quantity and habitat maintenance for this aquatic species. According to the Intergovernmental Panel on Climate Change (IPCC 2007, p. 1), “Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.” Localized projections suggest the southwest U.S. may experience the greatest temperature increase of any area in the lower 48 states (IPCC 2007, p. 8), with warming increases in southwestern states greatest in the summer. The IPCC also predicts hot extremes, heat waves, and heavy precipitation will increase in frequency (IPCC 2007, p. 8). Karl *et al*. (2009, p. 12) suggest that warming of the United States climate is already happening and is increasing.

There is also high confidence that many semi-arid areas like the western United States will suffer a decrease in water resources due to climate change (IPCC 2007, p. 7; Karl *et al*. 2009, pp. 129-131), as a result of less annual mean precipitation and reduced length of snow season and snow depth. Milly *et al*. (2005, p. 347) also project a 10 to 30 percent decrease in precipitation in mid-latitude western North America by the year 2050 based on an ensemble of 12 climate models. Even under lower emission scenarios, recent projections forecast a 4 to 6 ºF (2 to 3 ºC) increase in temperature and a 10 percent decline in precipitation in western Texas by 2080-2099 (Karl *et al*. 2009, pp. 129-130). Assessments of climate change in west Texas suggest that the area is likely to become warmer and possibly slightly drier (TWDB 2008, pp. 22-25).

The potential effects of future climate change could reduce overall water availability in this region of western Texas and compound the threat of declining flows from the San Solomon Spring system. If this were to occur, spring flows could decline directly because of decreases in recharge from declining precipitation or indirectly as a result of increased pumping of groundwater to accommodate human needs for additional water supplies (Mace and Wade 2008, p. 664). Other potential effects of climate change on the physical and biological environment of the springs are possible, but difficult to predict as no formal vulnerability assessment has been completed. The species may be highly sensitive to the effects of climate change because its habitat is closely dependent on stable flows (from precipitation) and water temperatures. Other indirect effects of climate change include alteration of water quality, invasion of nonnative species, increased disease susceptibility, or other factors are also possible. We lack sufficient certainty to know how climate change may specifically affect this species. However, because of the extremely small range and dependence on specific environmental conditions, any potential changes to its environment could result in the extinction of the species.

The species also has no opportunity to migrate and it is unlikely it could be successfully relocated to alternate environments. As a consequence, its capability to adapt to environmental changes from climate change is presumed low. Therefore, although the imminence of the threats related to climate change can be considered low, the magnitude of effects of those changes on the species is considered high.

Habitat Quality: Another threat to Phantom springsnail habitat is the potential degradation of water quality from point and nonpoint pollutant sources. This can occur either directly into surface water or indirectly through contamination of groundwater that discharges into spring run habitats used by the species. The primary threat for contamination comes from herbicide and pesticide use in nearby agricultural areas.

The natural ciénega habitats of the Balmorhea area have been mostly altered over time to accommodate agricultural irrigation. Most significant was the draining of wetland areas and the modification of spring outlets for development of human use of the water resources. Although the physical condition of the areas has changed dramatically over time as a result of human actions, at least a portion of the native biota remain. Two of the three known occurrences of the species are in degraded habitats (exception is East Sandia Spring) because the natural conditions of the springs have been substantially modified for human use. Any additional modifications to the spring flow habitats will further threaten the species.

Conclusion: Based on our evaluation of current spring modifications, loss of spring integrity, and groundwater withdrawals and climate change, we conclude the Phantom springsnail is threatened due to the present and threatened destruction, modification, or curtailment of its habitat and range.

B. Overutilization for commercial, recreational, scientific, or educational purposes.
Overutilization is not known to be a factor threatening the Phantom springsnail.

C. Disease or predation.
Disease and predation are not known to be factors threatening the Phantom springsnail.

D. The inadequacy of existing regulatory mechanisms.
Texas State law provides no protection for this invertebrate species. There is no existing Federal, State, or local regulatory mechanism providing protection for these species. However, the Phantom springsnail is afforded some protection indirectly due to the presence of two fishes

(Comanche Springs pupfish (*Cyprinodon elegans*) and Pecos gambusia (*Gambusia nobilis*)) listed as endangered by State and Federal governments and that occupy similar habitats. However, the springsnail may be more sensitive to changes in water quality or other habitat changes than the fish and are likely more directly threatened by the presence of the exotic *Melanoides* snail than the endangered fish (see Factor E below).

Some protection for the habitat of this species is provided with the ownership of the springs by Federal (Phantom Lake) and State (San Solomon) agencies, and by TNC (East Sandia). However, this land ownership provides no protection for maintaining necessary groundwater levels to ensure adequate spring flows. Texas groundwater resources were historically under the “Rule of Capture,” which provides limited opportunity for regulation of pumping or management of groundwater resources (Potter 2004, pp. 1-10). Local underground water districts are now the method for groundwater management in Texas. Although there are three groundwater districts in the area that could manage groundwater to protect spring flows, it is uncertain if the district would limit groundwater use to provide for conservation of surface water flows for natural resource benefits (Booth and Richard-Crow 2004, p. 38; Caroom and Maxwell 2004, pp. 53-54).

Based on our evaluation, we conclude that the protections from the existing regulatory mechanisms are not adequate to limit or alleviate the threats to the Phantom springsnail, even considering the protections resulting from the co-occurrence of the two federally-endangered fishes.

E. <u>Other natural or manmade factors affecting its continued existence</u>.

Exotic Species

During the 1990s, an exotic snail, *Melanoides* spp., was discovered in Phantom Lake Spring (B. Fullington, University of Texas-El Paso *in litt*., 1993; McDermott 2000, pp. 1-43). The species has been at San Solomon Spring for some time longer, but is not found in East Sandia Spring. In many locations at San Solomon Spring, this exotic snail dominates the substrate in the small stream channel. The effects of this introduction are not known. However, this exotic snail is likely competing with the native snails for space and resources. Other changes to the ecosystem from the dominance of this species could occur and could have detrimental effects to the native invertebrate community.

Limited Distribution and Stochastic Events

The Phantom springsnail may be susceptible to threats associated with limited distribution and impacts from stochastic events. Stochastic events from either environmental factors (random events such as severe weather) or demographic factors (random causes of births and deaths of individuals) are also heightened threats to the species because of the limited range (Melbourne and Hastings 2008, p. 100). Finally, the small range of this snail does not provide any opportunity for natural recolonization if any of these factors resulted in a local extirpation event.

Based on our evaluation, we conclude that Phantom springsnail is threatened by the impacts of other natural and manmade factors, including exotic species, climate change, and limited distribution.

CONSERVATION MEASURES PLANNED OR IMPLEMENTED: This species is a high priority species in the Wildlife Action Plan of Texas (TPWD 2005, p. 354). The Service has had a long and active partnership with the Reeves County Water Improvement District #1, TPWD, TNC, Reclamation, and others in conservation of the endangered fishes that occur in the springs and irrigation system in the Balmorhea area of Reeves and Jeff Davis counties. The benefits of these partnerships extend to the conservation of endemic invertebrates as well. TPWD owns and manages Balmorhea State Park, not only for the benefit of visitors, but also for the conservation of the rare and protected aquatic species. The San Solomon Ciénega project by TPWD, the Water District, and a host of other cooperators was a significant step in conservation of the area's aquatic biota (McCorkle *et al*. 1998, pp. 36-41) and increased habitat available for the snails. TPWD provides some management assistance to Reclamation for maintenance of the property at Phantom Lake Spring.

The Service has been working with TPWD and Reclamation to maintain the aquatic habitat at Phantom Lake Spring through the installation and maintenance of a pumping system there. Section 6 funds (Grant No. TX-E-53) have been used to upgrade the pumping system and to continue this project.

The Service provided funds (through a section 6 grant) to the Texas Water Development Board to conduct a regional groundwater study (Grant No. TX-E-19). The purposes of the study included investigating the source of groundwater that supports area springs and determining the causes for spring flow declines at Phantom Lake Spring. The final study was completed by the Texas Water Development Board in May 2005 (Texas Water Development Board 2005); however, there were no conclusive results that suggested the cause of the decline in spring flow was directly related to human activities.

In August 2009, TPWD was issued a 10(a)(1)(B) permit and Habitat Conservation Plan (HCP) for the Management Plan for Balmorhea State Park. This plan authorizes "take" of endangered fish in the park for ongoing management activities while minimizing impacts to the aquatic species, particularly the endangered fish. The activities included in the HCP are a result of TPWD operation and maintenance of the Park, including the draw downs associated with cleaning the swimming pool and vegetation management within the refuge canal and ciénega. The HCP authorizes a very small amount of take of the covered fish species, but contains conditions for TPWD to ensure compliance with the Act by demonstrating measures to minimize and mitigate any possible adverse effects to the covered species (Permit No. TE-183172-0).

During 2009 and 2010, TPWD removed a portion of the existing refuge canal and relocated it away from the motel and constructed a new ciénega habitat at Balmorhea State Park. This will provide additional natural habitat for the endangered fishes and candidate invertebrates. The Service cooperated on this project by providing funds through a section 6 grant to TPWD for the design and construction of the project (Lockwood 2010).

SUMMARY OF THREATS: The primary threat to this species is the loss of surface flows due to declining groundwater levels. Although much of the land immediately surrounding their habitat is owned and managed by TNC, Reclamation, and TPWD, the water needed to maintain their habitat has declined due to a reduction in spring flows, possibly as a result of private groundwater pumping in areas beyond those controlled by these landowners. As an example, Phantom Lake Spring, one of the sites of occurrence, has already ceased flowing and aquatic habitat is supported only by a pumping system. In addition, the potential effects of future climate change could further exacerbate the impacts of declining groundwater availability. We find that the Phantom springsnail is warranted for listing throughout all its range, and, therefore, find that it is unnecessary to analyze whether it is threatened or endangered in a significant portion of its range.

RECOMMENDED CONSERVATION MEASURES: Needed conservation measures for the near-term include: maintaining spring flows in all of the San Solomon Spring System through groundwater management and conservation; monitoring the distribution, abundance, and habitat use of the snails in comparison to the *Melanoides* snail to determine potential effects of this exotic species; and establishing a captive propagation program for the species.

LISTING PRIORITY:

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	**Imminent**	Monotypic genus	1
		Species	2*
		Subspecies/population	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/population	6
Moderate to Low	Imminent	Monotypic genus	7
		Species	8
		Subspecies/population	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

Magnitude: HIGH. Threats of spring flow loss will result in complete habitat loss and permanent elimination of all populations of the species.

Imminence: IMMINENT. Drying of Phantom Lake Spring is happening currently and will likely extirpate this population in the near future. Declining spring flows in San Solomon Spring are also becoming evident and will impact that spring site as well within the foreseeable future.

Yes Have you promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed?

Is Emergency Listing Warranted? No. Emergency listing of the Phantom springsnail is not warranted at this time. Because the species is sympatric with the two endangered fishes, it benefits from ongoing conservation actions that have been and are being undertaken to recover the fishes. In addition, the nature of the main threat of spring flow loss is not a straightforward enforcement action under the Endangered Species Act, and, therefore, emergency listing of the Phantom springsnail is not likely to afford them immediate protection that would either alleviate the threats or prevent extinction.

DESCRIPTION OF MONITORING: Service personnel have monitored the habitat at Phantom Lake Spring (maintained by a pumping system) over the last few years and confirmed presence of the Phantom springsnail several times per year, most recently trips made in May and September 2009 (Allan 2009a, 2009b). In addition partners from TPWD, Reclamation, New Mexico Department of Game and Fish, Lehigh University, and others provide irregular monitoring of the pump system and biota (observation) at Phantom Lake Spring. Spring habitats are generally monitored by TPWD and TNC at San Solomon and East Sandia springs, respectively. Flows from San Solomon Spring are monitored by U.S. Geological Survey, Reclamation, and the Water District on a continual basis.

Aquatic invertebrates were sampled at San Solomon Spring and Phantom Lake Spring in June, September, and December 2008 by personnel from Miami University-Ohio and New Mexico Department of Game and Fish. All three candidate invertebrates were present in good numbers at San Solomon Spring in each survey (Lang 2008, New Mexico Department of Game and Fish, pers. comm.). At Phantom Lake Spring, in June and September 2008, no diminutive amphipods or Phantom springsnails were collected. Only one Phantom Cave snail was collected. However, in early December 2008 all three species were again found and "showed sign of active reproduction—juveniles present" (Lang 2008, New Mexico Department of Game and Fish, pers. comm.). Presence/absence monitoring of the species at Phantom Lake Spring in May and September 2009 confirms it is continuing to persist at that highly vulnerable location.

COORDINATION WITH STATES

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment:

On March 4, 2010, the Service contacted TPWD by email requesting information on the status of this and other candidate species. They provided no new information in their March 30, 2010, email response (Wendy Gordon, TPWD, pers. comm, 2010).

Indicate which State(s) did not provide any information or comments: NA

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APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: ______________________________ May 21, 2010
Acting Regional Director, Fish and Wildlife Service   Date

Concur: ______________________________ Date: October 22, 2010
ACTING
Director, Fish and Wildlife Service

Do not concur: ______________________________ ______________
Director, Fish and Wildlife Service   Date

Director's Remarks:

Date of annual review: April 2010
Conducted by: Nathan Allan

Comments: